

Small Launch Vehicle Trade Space Definition: Development of a Zero Level Mass Estimation Tool with Trajectory Validation

Abstract

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Recent high level interest in the capability of small launch vehicles has placed significant demand on determining the trade space these vehicles occupy. This has led to the development of a zero level analysis tool that can quickly determine the minimum expected vehicle gross liftoff weight (GLOW) in terms of vehicle stage specific impulse (Isp) and propellant mass fraction (pmf) for any given payload value. Utilizing an extensive background in Earth to orbit trajectory experience a total necessary delta v the vehicle must achieve can be estimated including relevant loss terms. This foresight into expected losses allows for more specific assumptions relating to the initial estimates of thrust to weight values for each stage. This tool was further validated against a trajectory model, in this case the Program to Optimize Simulated Trajectories (POST), to determine if the initial sizing delta v was adequate to meet payload expectations.

Presented here is a description of how the tool is setup and the approach the analyst must take when using the tool. Also, expected outputs which are dependent on the type of small launch vehicle being sized will be displayed. The method of validation will be discussed as well as where the sizing tool fits into the vehicle design process.